MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

DET5028 – INDUSTRIAL ELECTRONICS

(Diploma in Electronic Engineering)

1 MARCH 2019

3:00 PM – 5:00 PM

(2 HOURS)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **6** pages (excluding the cover page) with **5** questions.
2. Answer **ALL** questions. All necessary working steps **MUST** be shown.
3. Write all your answers in the answer booklet provided.

QUESTION 1 [20 marks]

(a) For each of the following cases, draw a **PLC ladder diagram** where the input sections of the ladder diagrams are depicted as below. In each case, the output section is connected to a motor. Also, provide the **logical function** for each case by using AND/OR/NOT operators.

(i) There are two normally-open (NO) contacts in parallel and both of them are in series with one normally-closed (NC) contact.

[2 + 1 marks]

(ii) There are two NO contacts in series, where the first NO contact is in parallel with one NC contact.

[2 + 1 marks]

(iii) There are two NC contacts in series and both of them are in parallel with one NO contact.

[2 + 1 marks]

(b) Develop a PLC ladder logic program that requires the following specifications for a pumping station of water which is pumped from a storage tank into a pressure tank. **The answer should be drawn into a single ladder diagram only.**

(i) When an operator presses a start push button momentarily, the pump motor will pump water from the storage tank into the pressure tank.

(ii) When the pressure tank is full, the operator presses a stop push button to stop the pump motor.

(iii) When the stop push button is pressed for 5 seconds, a discharge path will be opened to release the water.

(iv) The start push button then is pressed to close the discharge path and the pump motor will start running again.

Note: If the stop push button is pressed for a short while (less than 5 seconds), it will stop the pump motor only. If it was pressed for at least 5 seconds, it will stop the pump motor AND open the discharge path.

[11 marks]

Continued ...

QUESTION 2 [20 marks]

(a) In the resistor-capacitor circuit as shown in *Figure 2-1*, the resistances of R_1 and R_2 for the full firing range of Silicon-Controlled Rectifier (SCR) are 50 kΩ and 450 kΩ, respectively. Calculate the **range of the time constant** when $C = 0.1\ \mu F$. Draw the **voltage waveforms** across the SCR and across the load for a firing angle of 140°.

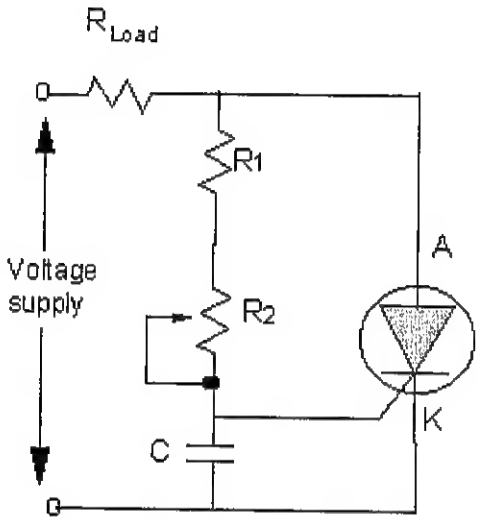

Figure 2-1

[4 + 6 marks]

(b) The circuit in *Figure 2-1* is transformed consequently into the circuit as shown in *Figure 2-2*. Determine the **gate-trigger current** when the peak-input voltage is 170 V for a firing angle of 90°. R_1 and R_2 are given as 1.5 kΩ and 5.3 kΩ, respectively. Draw the **voltage waveforms** across the SCR and across the load.

Continued ...

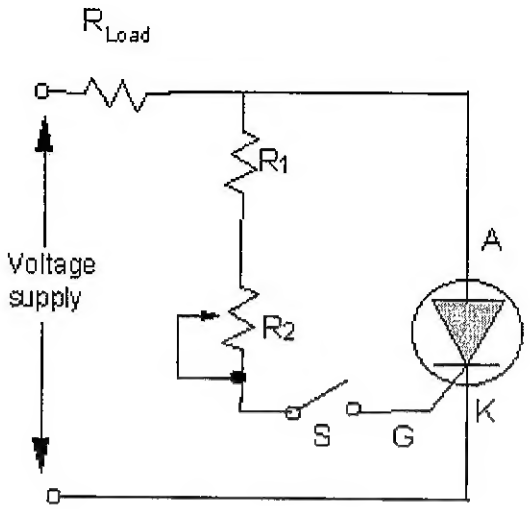

Figure 2-2

[4 + 6 marks]

Continued ...

QUESTION 3 [20 marks]

(a) An indicator wire in a strain gauge has a new length of 41.8 mm and new resistance of 111.25 Ω after it is strained. The wire's length and resistance were previously 40 mm and 100 Ω, respectively. Determine the **strain** and **gauge factor** of the wire.

[4 + 4 marks]

(b) A Resistance Temperature Detector (RTD) with R_T = 180 Ω is placed in a measuring circuit, where the temperature coefficient of resistivity is $\alpha = 0.003902/°C$ and the resistance of the RTD is 115 Ω at 10 °C.

(i) Compute the resistance of the RTD at 150 °C before its self-heating occurs.

[2 marks]

(ii) Calculate the **temperature rise** and the **voltage** across the measuring circuit with the current flow of 4 mA and self-heating factor of $F_{SH} = 0.4°C/mW$

[4 + 2 marks]

(iii) Obtain the new resistance of the RTD at 150 °C after its self-heating occurs.

[4 marks]

Continued ...

QUESTION 4 [20 marks]

An optical encoder has a direction-indicating ability. Its output is a 9-bit signed magnitude binary, where the 9th bit on the far left is solely used to indicate direction and not used to indicate angular rotation. This 9th bit on the far left represents either sign bit 0 (disc rotating clockwise), or 1 (disc rotating counter clockwise). The gear ratio is 8 between the large gear and the small gear with 90 slit openings on its rotating disc.

(a) How far the measured shaft has to revolve to increase the binary counter by 1 bit?

[2 marks]

(b) What is the limit of the shaft movement required to guarantee the counter never goes beyond its maximum capacity?

[4 marks]

(c) If the measured shaft rotates 1/3 turn in counter clockwise direction, evaluate the content of the binary counter.

[3 marks]

(d) Obtain the **direction** and amount of shaft **movement** represented by a binary output of $[0\ 1101\ 1011]_2$.

[3 + 1 marks]

(e) If the measured shaft rotates 85° in clockwise direction, compute the content of the binary counter.

[3 marks]

(f) Determine the **direction** and amount of shaft **movement** represented by a binary output of $[1\ 1100\ 0011]_2$.

[3 + 1 marks]

Continued ...

QUESTION 5 [20 marks]

A shunt-configured DC motor has an armature resistance of 10 Ω and a field resistance of 750 Ω. The supply voltage and the line current are 100 V and 1.2 A, respectively.

(a) Sketch the equivalent circuit for a shunt-configured DC motor.

[4 marks]

(b) Find the amount of current passes through the field winding.

[2 marks]

(c) Determine the amount of current flow in the armature winding.

[2 marks]

(d) How much counter electromotive force (CEMF) is generated by the armature?

[2 marks]

(e) Calculate the range of field current if a 140 Ω-rheostat is placed in series with the shunt field circuit.

[3 marks]

(f) Consider that there is an increase in mechanical drag on the motor shaft, and it causes more current to be drawn from the DC supply, such that the total current is now 2.1 A. What is the new value of armature current?

[2 marks]

(g) If CEMF is reduced to 82.5 V, how much current flows in the armature loop?

[2 marks]

(h) Draw the speed and torque characteristics of a shunt-configured DC motor.

[3 marks]

End of Page